NOAA Technical Memorandum NESDIS AISC 1

ASSESSMENT MODELS FOR SURFACE DISPERSION OF MARINE POLLUTANTS

Kurt W. Hess, Fred G. Everdale,
and Peter L. Grose

Washington, DC
May 1985

U.S. DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration / National Environmental Satellite, Data, and Information Service

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Kurt W. Hess, Fred G. Everdale, and Peter L. Grose

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ABSTRACT. The dispersion of oil on the sea surface by climatological winds and currents can be simulated with a set of three computer programs. One program (TRANS) constructs a series of transition matrices. Each matrix determines how much of the oil is advected into the adjacent grid elements over one timestep. The second program (DISPRS) uses the transition matrices to simulate oil pollution cases, such as operational ship discharges or oil well blowouts. The third program (BLENDR) adds the results generated by DISPRS for the same pollution case, but with different weathering rates. Instructions for running these programs are included in this report.

1. INTRODUCTION

The Marine Environmental Assessment Division (MEAD) has developed a technique for simulating the fate of a pollutant on the ocean surface under the action of climatological winds and currents. This technique was originally developed for the National Oceanic and Atmospheric Administration's (NOAA'S) Office of Ocean Resources Coordination and Assessment (ORCA) to model the long-term distribution of surface oil produced by the monthly-varying discharges of ship traffic. The method can also be used to simulate the oil distribution from a single-source spill of such a long duration that the currents and winds can be assumed to act like their climatological averages. Details of the advection and weathering schemes can be found in Grose, et al., 1982. The method was applied to the Ixtoc oil spill in the Gulf of Mexico in Grose, et al. , 1983a, and to the East Coast of the U.S. in Grose et al., 1983b. Results for the Gulf of Mexico spill are shown in Fig. 1.

The pollution distribution is computed on a latitude-longitude grid with 1/2 by 1/2 degree elements. The grid mesh for the Gulf of Mexico is shown in Fig. 2, the mesh for the East Coast is shown in Fig. 3, and for the West Coast in Fig. 4. Each water grid element has data on the climatological wind and current, and the presence or absence of land.

The pollutant distribution at the end of each timestep is determined by the multiplication of the starting distribution by a transition matrix. The matrix determines how much of the oil in a particular grid cell is dispersed to each of the adjacent eight grid cells. Because the characteristics of the climatological winds and currents change over the course of the year, a separate matrix was generated for each month. Once the set of 12 matrices for a region (the East Coast, the Gulf of Mexico, or the West Coast) has been constructed, it can be applied repetively to different scenarios, resulting in a great saving of computer time.

The assessment technique described here consists of three interactive Fortran programs which run in succession. The program TRANS uses wind and current data to create the transition matrices. The program DISPRS uses the transition matrices and information on pollutant discharges to compute the monthly distributions of a single pollutant with a fixed weathering rate. The program BLENDR finds the final pollutant distribution by combining the results for components with different weathering rates. The first step, however, is the creation of the transition matrices.

2. THE TRANSITION MATRICES

The central feature of the oil dispersion model is the transition matrix. The set of 12 monthly matrices per region needs to be generated only once. For each grid element and month the matrix consists of a set of nine values. These values are the fractions of the pollutant that will disperse to the eight adjacent grid elements at the end of one timestep, and the fraction that will remain. Data necessary for the calculation of the fractions are the climatological winds and currents. The wind data are in the form of a histogram, which has two sets of nine values for each month. One set is the relative frequency of wind toward each of the eight major compass directions and calm, while the second set is the mean speed of the wind toward these major directions.

The computational grids for each coastal section are shown in Figs. 2, 3, and 4. Each has a grid size of 1/2 by 1/2 degree. The Gulf of Mexico grid extends from 18.0 N to 30.5 N (25 grid rows), and from 98.0 W to 81.0 W (34 grid columns). The East Coast grid extends from 24.0 N to 45.5 N (43 grid rows), and from 81.5 W to 65.0 W (33 grid columns). The West Coast grid extends from 30.5 N to 49.5 N (37 grids), and 132.5 W to 116.0 W (33 grids). Array data is also ordered sequentially, starting at the lower left corner, counting up columns. The program generates the transition matrices for one region at a time.

The program TRANS determines, for each cell in one of the three regions, the fractions to be advected to the adjacent grid cells in the following way. First, one of the compass directions is selected, and the vector sum of the wind drift current from that direction and the climatological water current is created. The wind current has the same direction as the wind, but only 3.5 percent of its magnitude. The components of this vector are multiplied by the timestep to give the northward and eastward displacements. These displacements, which can be positive or negative, are then checked against the effective grid height and width. The effective grid dimensions are either the actual height and width for water cells, or the minimum wetted height or width for part-land, part-water cells. If the north or east displacements are less than their respective effective grid dimensions, the program translates the outline of the central grid element to a new position as determined by the displacements. A schematic picture of this displaced outline is shown in Fig. 5. The translated cell outline will overlap the central cell and one or more of the adjacent cells. The contribution by this direction's vector to the total fraction dispersed to each of the adjacent overlapped cells will then be the product of the ratio of the overlapped area in the adjacent cell to the total area in the central cell, and the frequency of the wind from that direction.

If the displacement in either direction is greater than the effective cell dimension in that direction, the displacement is reduced to the effective value. These cells with reduced displacements are counted, and the total is printed for each month. If a significant number of displacements have been reduced, the program TRANS should be rerun with a smaller timestep.

Finally, another compass direction is selected, and the next set of contributions to the total computed. When all eight directions have been selected, a check is made to insure that the sum of the fractions is unity.

To a large extent the climatological currents are directly related to the local mean winds. There is therefore the possibility that the influence of the climatological mean wind will be included twice: directly through the wind data and indirectly through the current data. To correct for this redundancy, the user has the option of subtracting the monthly mean vector wind from the value of the monthly compass wind at the time the wind drift current is computed.

The resulting values for all grid cells are then written to a direct access file for use in the program DISPRS.

3. OIL DISPERSION AND BLENDING

The fate of surface pollutants is computed by the program DISPRS for any given input distribution of material and discharge rates. The model was designed to run efficiently by accessing the transition matrices rather than computing advection at each timestep. At the start of each timestep an amount of oil or pollutant, based on the discharge rate, is added to that already present in each grid element. The pollutant is then weathered by removing from each cell a fraction of the oil present, based on the material's half-life. Next the pollutant is dispersed to the eight adjacent grid elements by applying the transition matrices. The program DISPRS can print out maps of surface distribution at the end of each month.

There are three methods of prescribing oil or pollutant discharge inputs. The first is by referencing one of the available input files. These files contain the location and monthly pollutant discharge into cells in units of gallons per month (each month is taken to be 30 days). Several of these files are described in Section 4. The second method is to enter the word UNIT when prompted. The programs adds an amount of pollutant to each grid element at a rate equal to 0.05 gallons per month per square kilometer. The last way is by a specific latitude-longitude site. DISPRS then adds pollutant at the rate described in the previous method, but only at the selected grid.

Oil is composed of many substances, each with a different half-life. The distribution of a realistic oil can be constructed by adding the results from separate dispersion runs for different weathering rates. This is done by the program BLENDR. BLENDR takes the output from DISPRS, multiplies the oil concentration by a user-supplied fraction, and saves the result. Maps of the distribution of a realistic oil can then be printed.

4. DATA FILES

The three models TRANS, DISPRS, and BLENDR rely on a set of data files for input values. The files have been generated at MEAD with information from various sources. A brief description of the files and their formats is included here for future reference. The structure of each of the data files is given in Table 1, and the structures of selected records is given in Table 2.

All the files have been named with a standard convention which identifies the coastal region and the type of data. The form is NNNNTRN.XXX. The first group of four letters defines the coastal area: for the East Coast, NNNN= EAST; for the Gulf of Mexico, NNNN=GULF; and for the West Coast, NNNN= WEST. The second group of three letters is TRN, which signify the dispersion model based on the use of transition matrices. The third group of designators is XXX. These letters stand for one of the file types, such as for control (XXX=CRL), geography (GEO), water currents (CUR), wind (WND), wind reference (REF), transition matrix (TRN), and transition matrix description (DES) files. The dispersion model output (DSP), and dispersion model header (HED) files have a somewhat different first group of letters (see Section 6.F.). Printed output files (PRN) will have the program name for their first group. A list of all the applicable files and their contents appears in the data sheet for each program (Sections 9 - 11).

The control files (.CRL) contain all the grid values and data file names needed to run the TRANS, DISPRS, or BLENDR programs for any of the three regions. The contents of each of the three control files is shown in Fig. 6. The first record of each file contains the region reference number (1=Gulf of Mexico, 2=East Coast, 3=West Coast). The second and third records contain the names of the geography and current files. The fourth record has the number of stations in the wind reference file. The names of the wind reference, wind, description, and dispersion files follow. The ninth record contains a string of seven numbers. In order, they are the number of water grid cells in the file, the gross number of cells in the geography file, the number of grid lines (see Figures 2 - 4), the number of grid columns, the latitude of the bottom of the grid, the longitude of the western side of the grid, and the timestep (hours) used by the models. When any of the programs are run, the first prompt is for the name of the control file.

The geography files (.GEO) are unformatted and direct access, and contain information on the water cells. Each grid cell has at least eight values. They are the sequence number, an offset number, grid row, grid column, latitude of grid element center, longitude of grid element center, descriptor characters, and cell area (square kilometers). The sequence number was determined by counting water cells, starting at the lower left corner, and proceeding up columns. Non-water cells have the sequence number zero. The offset is the value added to the relative longitude index to get the actual longitude index. The descriptor characters are OFFS (offshore), COAS (coastal), OUTS (outside), or LAND. All grid elements designated as coast have an additional four pairs of values which are the mean depth (meters) and width of wetted grid (kilometers) for the north, east, south, and west sides.

The current files (.CUR) are formatted and sequential access. The first record has the number (1X,I4) of records of current data, and a descriptive header. This record is followed by formatted records, each with a sequence number (1X,I4), the latitude and longitude of the grid center (2F8.2), and the eastward and northward components of the current (cm/s) for each month (24I4). Current values for land are denoted by 888. Missing values for water cells are denoted by 999. Surface water current data for the Gulf of Mexico and the West Coast is based on the output of a numerical model for geostrophic currents which was designed and run by Dynalysis of Princeton (Blumberg and Mellor, 1981). The current data for the East Coast was obtained from Navy ship drift data (U.S. Naval Oceanographic Office, 1978, 1981). Some of our grid cells near land had no corresponding values from the data bases. Missing values in the Gulf were filled in after consulting a large number of published reports on the local currents. Missing values for the East Coast were supplied by a weighted averaging of the nearest data values. Missing values for the West Coast were filled in with values that were approximately the average of the local current vectors. Plots of the surface current vectors for the Gulf of Mexico for the months of January and July are given by Grose, et al., 1982. Plots of the surface currents for January, April, July, and October for the East Coast are shown in Grose, et al., 1983b, and for the West Coast are given in Figures 7 - 10.

The wind reference file (.REF) is formatted and sequential access, and specifies which wind record is to be used by which grid cell. The first 10 records describe the wind file. The eleventh record contains the format to be used to read the reference data. The next two records have more descriptive information. The remaining records contain the reference data. The number of records is given in the control file. The reference data is the latitude and longitude of the grid element center, the grid record, the grid column, and a reference index number. Winds for the Gulf of Mexico were compiled from NOAA's National Climatic Data Center's data files, which were used to create the NOAA-Navy charts (U.S. Defense Mapping Agency, 1982), so the index number refers to those data. The East and West Coast wind histograms were constructed from data in MEAD's archive of forecasts made by the National Weather Service's Limited-area Fine-mesh Model (LFM) (Gerrity, 1977). The MEAD archive contains LFM boundary layer wind forecasts for the period from January 1, 1977 to December 31, 1982. The index numbers in these REF files are the LFM grid numbers. A negative index number means that the site of the wind data is within the grid cell.

The wind files (.WND) are unformatted and direct access, and contain the wind histograms. In each record, the first four numbers are the sequence number, latitude and longitude of the data point, and a dummy index number. Next comes four pairs of speed (knots) and frequency (fraction of time) values for the directions 180., 235., 270., and 315. degrees (these are the direction toward which the wind blows). Then there are four pairs (speed, freq.) for directions 0., 45., 90., and 135. degrees. Finally, there is a speed (zero) and frequency for calm. Plots of the wind histograms for the Gulf of Mexico for January and July appear in Grose, et al., 1982, and for the East Coast for January, April, July, and October in Grose, et al., 1983b. Plots for the West Coast for these four months are given in Figures 11 - 14.

The transition matrix files (.TRN) are unformatted and direct access. The first four values are the record number, the grid mesh line and column , and cell's linear sequence number. The next nine numbers are the fractions which occupy the local cells after one timestep. The cell order is as follows: 1=N, 2=NE, 3=E,......7=W, 8=NW, and 9=center. The last value is the cell area.

The source files (.SOR) are formatted and sequential access, and contain the rate of oil discharge (gallons per month) into each grid cell. The first 10 records have information describing the nature of the pollution source. The eleventh record has the format to be used to read the discharge data. The next two records have more descriptive information. The remaining records contain the discharge data. Each record contains the grid sequence number, the cell column and line, and the discharges for each of the 12 months, starting in January.

Several source files have been constructed. The Bay of Campeche oil spill of 1979 was simulated by Grose, et al., 1982 with the file IXTOC.SOR. Operational discharges in the Gulf of Mexico were simulated by ORCA (Ehler, et al., 1983) with the source file GULFDISCH.SOR. Finally, hypothetical oil tanker operations in the Gulf of Mexico were analyzed with the files TAMPA1.SOR and TAMPA2.SOR (N.O.S., 1984).

The dispersion output file (.DSP) is unformatted and direct access, and contains the pollutant distribution. There is the sequence number, a dummy index, the column and row, and a set of 12 concentrations (one per month). The header file (.HED) contains descriptive information on the dispersion run.

5. RUNNING THE PROGRAM TRANS

A. Log into the system. Program and data files are in [ORCA.HESS].

B. Begin the execution by entering:

```
RUN TRANS
```

at the keyboard. See Section 9. for program data.

C. The screen will print

```
ENTER NAME OF CONTROL FILE :
```

Enter the desired name. For the Gulf of Mexico, use GULFTRN.CRL. For the East and West Coasts, the names are EASTTRN.CRL and WESTTRN.CRL, respectively. The screen will then print the contents of the file you have entered. If the file can't be opened (if it's missing), the program again asks for the file name.

D. Next, the screen will print

```
ENTER MONTHS TO RUN, AND PRINT INDEX :
```

A normal run will require 12 months, but a smaller number can be used for testing. The print index is as follows:

- 0 : print only the maximum currents and displacements.
- 1 : print maximums plus the two current arrays.
- 2 : print maximums, current arrays, plus the transition matrices (nine per month).

Enter these data as a pair of integers separated by a comma. A month number smaller than 1 or larger than 12 will be corrected to 1 or 12, respectively. Print indices out of range will likewise be corrected to either 0 or 2. The print index controls only what is written to the print file TRANS.PRN.

E. The program next prints

```
ENTER 1 TO SUBTRACT MEAN WINDS :
```

To some extent the water current data contain the influence of the local mean winds. This is true for currents obtained from numerical model runs of wind-driven flow, and from ship-drift data. The user can prevent the mean wind influence from being included twice by entering a 1.

F. The program notifies the screen as each month's matrices are completed, and writes the maximum currents and displacements. The transition matrices are stored in the unformatted, direct access file NNNNTRN.TRN, and descriptive information are written to NNNNTRN.DES. The (optional) printed arrays are written to the file TRANS.PRN for later access.

G. The results of the error checking are printed. The ratio of the maximum displacement distance to the grid size for both the north-south and the east-west currents are given. The program automatically reduces the displacement if it's greater than the grid size. If either ratio exceeds unity, you may want to use a smaller timestep. Typical TRANS.PRN contents (print index = 0) are shown in Fig. 15. The run is complete when the following words appear

FORTRAN STOP

6. RUNNING THE PROGRAM DISPRS.

A. Log into the system. The program and data files are in [ORCA.HESS].

B. Begin the execution by entering:

```
RUN DISPRS
```

at the keyboard. See Section 10. for program data.

C. The screen will print

```
ENTER NAME OF CONTROL FILE :
```

Enter the desired name. The names for the East Coast, West Coast, and Gulf of Mexico are, respectively, EASTTRN.CRL, WESTTRN.CRL, and GULFTRN.CRL. The file is opened and read immediately. If the file can't be opened, the screen again asks for the file name.

D. Next, the screen will print

```
ENTER WEATHERING HALF-LIFE, STARTING MONTH :
```

Enter two integers separated by a comma. The half-life is in days. It's the time over which half the present oil will evaporate. A negative value will cause no weathering. A value of zero will be set to 1. For the starting month, enter 1 for January, 2 for February, etc. A negative or zero value will be set to 1, and a value greater than 12 will be reset to 12.

E. The screen will print

```
ENTER MONTHS TO RUN, PRINT INDEX :
```

Enter two integers. The months is the total time of the simulation but not exceeding 15 months (for an annual cycle and a weathering rate of 30 days, start the simulation 3 months early to eliminate transient solutions). If the number of months is less than 1, it is set to 1. The print index, for the file DISPRS.PRN, is as follows:

- 0 : print map of concentration at end of month
- 1 : same as 0, but print map of initial concentration
- 2 : same as 1, but print maps of transition matrices (nine per month).

The print index is corrected if it's less than 0 or more than 2.

F. Next, you'll see

```
ENTER FILE FOR INPUT CONCENTRATIONS, OR 'UNIT', or 'SITE' :
```

Type in a file name for the oil discharge, such as AAAAA.SOR. Entering the word UNIT makes the discharges at all cells equal to 0.05 gallons per square kilometer per month. Entering the word SITE puts the program into the site-specific mode. The screen then prints

ENTER LATITUDE, LONGITUDE OF SITE :

Enter a pair of floating point numbers for the spill site. Longitudes in the three regions are positive. Then a discharge of 0.05 gallons per square kilometer per month will be added to the cell that contains the site.

G. Then,

ENTER NAME FOR OUTPUT FILE, OR CR :

Type in a file name for use to store the dispersion model output, such as NAME.AAA. NAME may have at most nine characters. The program will then create two files: one will be the header file, and have the name NAME.HED; the other will be the dispersion data file, with name NAME.DSP. If a carriage return (CR) is entered, file names will be constructed in the form AMMMSSSS.DSP and AMMMSSSS.HED. The letter A denotes the region; the Gulf of Mexico is G, the East Coast is E, and the West Coast is W. The next chracters denote the weathering half-life, in days. The number is set to 999 if the half-life is equal or greater than 999. If the half-life is negative, then MMM=CCC. The next set of characters denotes the pollutant source. For a source data file, SSSS is the first four letters in the name. If the name has fewer than four letters to the left of the ".", the character O is inserted as needed. For example, a Gulf of Mexico simulation of the Ixtoc oil spill with a half-life of 15 days would create the file name G015IXTO.DSP.

H. The program then runs. Messages are sent to the screen, and simultaneously written to a print file, DISPRS.PRN. The run is complete when the following words appear:

```
RUN COMPLETE. YOUR MAPS ARE IN DISPRS.PRN
MODEL OUTPUT IS IN NAME.DSP
HEADER INFORMATION IS IN NAME.HED
FORTRAN STOP
```

7. RUNNING THE PROGRAM BLENDR

A. Log into the system. Program and data files are in [ORCA.HESS].

B. Begin the run by entering:

```
RUN BLENDR :
```

at the keyboard. See Section 11. for program data.

C. The program will prompt by asking:

```
ENTER COMPONENT PERCENT, AND FILE NAME :
```

The percent (enter an integer) reflects the proportion of the total. The file name has the results of the dispersion runs. If the file can't be opened, the program asks for percent and name a second time. When the file is opened and read, the program prints the number of cells with data. This number should be equal to that in the control file (the first number in the ninth record).

D. The screen will continue to ask for percent and file name until either 1) zero is entered for the age, or 2) ten percentages and names have been entered.

E. Results of the run will be stored in files BLENDR.BLD and BLENDR.DES. Output maps (one for each month) will be written into a print file (BLENDR.PRN). The run is complete when the following words appear:

```
FORTRAN STOP
```

8. REFERENCES

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9. DATA SHEET FOR PROGRAM TRANS

PROGRAM NAME: TRANS   Rev. 1.00

FUNCTION: This program creates files containing transition matrices which determine how much of a pollutant in a grid is advected over one time interval to the eight adjacent grids by climatological winds and currents for each month. The files so created are used by the program DISPRS.

PROGRAM INFORMATION:

	Development Programmer:	Maintenance Programmer:
	Peter L. Grose	Kurt W. Hess
Location:	Ocean Assessments Div., NOS	Marine Environmental Assessment Div., NESDIS
Phone:	FTS 443-8921 (301)-443-8921	FTS 634-7379 (202)-634-7379

Computer: Digital Equipment Corp. VAX 11/750

Language: FORTRAN 77 (VAX Rev 3.60)

Source file creation date:

Original Release: - December 5, 1984

Run time: 0.5 to 1.5 min. per month

Link line: LINK TRANS.FOR

Program Contents:

Name	Lines	Net Array Size (Words)
MAIN	507	14,000
FLIN	21	100
GEOM	144	100
CELKSE	73	100

Program Files (1 block = 512 bytes):

File Name	Space (blocks)	Contents
TRANS.FOR	43	Source Code
TRANS.OBJ	36	Object Code
TRANS.EXE	30	Executable Code

Data Files:

File Name	Space (blocks)	Read/Write	Contents
GULFTRN.CRL	1	R	Control File
EASTTRN.CRL	1	R	"
WESTTRN.CRL	1	R	"
GULFTRN.GEO	118	R	Geography File
EASTTRN.GEO	111	R	"
WESTTRN.GEO	105	R	"
GULFTRN.CUR	141	R	Currents File
EASTTRN.CUR	424	R	"
WESTTRN.CUR	542	R	"
GULFTRN.REF	24	R	Wind References
EASTTRN.REF	33	R	"
WESTTRN.REF	96	R	"
GULFTRN.WND	410	R	Wind Data File
EASTTRN.WND	480	R	"
WESTTRN.WND	480	R	"
GULFTRN.DES	1	W	Matrix Descriptors
EASTTRN.DES	1	W	"
WESTTRN.DES	1	W	"
GULFTRN.TRN	778	W	Transition Matrices
EASTTRN.TRN	978	W	"
WESTTRN.TRN	957	W	"

10. DATA SHEET FOR PROGRAM DISPRS

PROGRAM NAME: DISPRS — Rev. 1.00

FUNCTION: This program creates files containing maps of pollution distribution at the end of each month due to continuous discharges throughout the month. The advection of material is by climatological winds and currents, and is determined by application of the transition matrices.

PROGRAM INFORMATION:

Development Programmer:	Maintenance Programmer:
Peter L. Grose	Kurt W. Hess
Location: Ocean Assessments Div., NOS	Marine Environmental Assessment Div., NESDIS
Phone: FTS 443-8921 (301)-443-8921	FTS 634-7379 (202)-634-7379

Computer: Digital Equipment Corp. VAX 11/750

Language: FORTRAN 77 (VAX Rev 3.60)

Source file creation date:

Original Release: - December 6, 1984

Run time: 1.0 to 1.5 min. per month

Link line: LINK DISPRS.FOR

Program Contents:

Name	Lines	Net Array Size (Words)
MAIN	494	14,000
FLIN	21	100
GEOM	144	100
CELKSE	73	100

Program Files (1 block = 512 bytes):

File Name	Space (blocks)	Contents
DISPRS.FOR	36	Source Code
DISPRS.OBJ	32	Object Code
DISPRS.EXE	26	Executable Code

Data Files:

File Name	Space (blocks)	Read/Write	Contents
GULFTRN.CRL	1	R	Control File
EASTTRN.CRL	1	R	"
GULFTRN.CRL	1	R	"
GULFTRN.DES	1	R	Matrix Descriptors
WESTTRN.DES	1	R	"
WESTTRN.DES	1	R	"
GULFTRN.TRN	778	R	Transition matrices
EASTTRN.TRN	978	R	"
WESTTRN.TRN	957	R	"
D106.SOR	1	R	East Coast Dump Site
EASTCRUD.SOR	27	R	Crude Oil Discharges
EASTPROD.SOR	74	R	East Coast Discharges
GULFCRUD.SOR	109	R	Gulf Crude Oil Discharges
GULFPROD.SOR	109	R	Gulf Products
GULFDISCH.SOR	109	R	Gulf Discharges
IXTOC.SOR	109	R	Gulf Oil Source File
TAMPA1.SOR	2	R	Tampa Bay Lease Sites
TAMPA2.SOR	2	R	Tampa Bay Lease Sites
AMMMSSSS.HED	1	W	Dispersion Header File
AMMMSSSS.DSP	98	W	Dispersion Results

11. DATA SHEET FOR PROGRAM BLENDR

PROGRAM NAME: BLENDR Rev. 1.00

FUNCTION: This program creates files containing maps of pollutant distribution at the end of each month by summing the output from the dispersion model for various weathering rates for one discharge case.

PROGRAM INFORMATION:

Development Programmer:	Maintenance Programmer:
Peter L. Grose	Kurt W. Hess
Location: Ocean Assessments Div., NOS	Marine Environmental Assessment Div., NESDIS
Phone: FTS 443-8921 (301)-443-8921	FTS 634-7379 (202)-634-7379

Computer: Digital Equipment Corp. VAX 11/750

Language: FORTRAN 77 (VAX Rev 3.60)

Source file creation date:

Original Release: - October 4, 1984

Run time: 0.6 min. per month

Link line: LINK BLENDR.FOR

Program Contents:

Name	Lines	Net Array Size (Words)
MAIN	186	14,000

Program Files (1 block = 512 bytes):

File Name	Space (blocks)	Contents
BLENDR.FOR	9	Source Code
BLENDR.OBJ	9	Object Code
BLENDR.EXE	9	Executable Code

Data Files:

File Name	Space (blocks)	Read/Write	Contents
BLENDR.HED	1	W	Header File
BLENDR.BLD	978	W	Model Results
BLENDR.PRN	1	W	Maps of Model Results
AMMMSSSS.HED	1	R	Dispersion Model Descriptor File
AMMMSSSS.DSP	98	R	Dispersion Model Output

Table 1. Structure of data files used by the programs. Data format code is as follows: I = integer, F = floating point, A = alphanumeric (ASCII), U = unformatted, V = variable (usually read in elsewhere). Records marked by an asterisk (*) are described in Table 2.

File	Record	Format	Contents
Control (.CRL)	1	I5,A20	basin number and title
	2	A30	geography file name
	3	A30	water currents file name
	4	I4	number of records in wind reference file
	5	A30	wind reference file name
	6	A30	wind data file name
	7	A30	name of transition matrix descripter file
	8	A30	transition matrix file name
	9	4I4,2F5.1,I4	grid mesh parameters
	10	A30	dispersion results file name
	11	A30	name of header file for dispersion results
Geography (.GEO)	*1-END	U	grid data
Currents (.CUR)	1	I5	no. of records which follow
	*2-END	I5,2F8.2,24I4	water current data values
Wind Ref. (.REF)	1	A72	basin identification
	2-10	A72	general description of data and basin
	11	A40	format of data which follow
	12-13	A72	description of data
	*14-END	V	grid data (format from record 11)
Wind (.WND)	*1-END	U	wind data
Transition Matrix(.TRN)	*1-END	U	matrix values

Table 1 (Cont'd)

File	Record	Format	Contents
Matrix Description (.DES)	1	A72	title and date of matrix generation
	2	A72	number of cells and timestep
	3	A72	first and last months of run
	4	A72	currents file used
	5	A72	wind file used
	6	A72	index for mean wind subtraction (1=yes, otherwise=no)
Dispersion Results(.DSP)	*1-END	U	grid location, concentrations
Dispersion Header (.HED)	1	A72	title, date of dispersion model run
	2	A72	pollutant half-life (days), run timestep (hr)
	3	A72	first and last months of run
	4	A72	currents file used
	5	A72	wind file used
	6	A72	pollution source file
Source (.SOR)	1	A72	title
	2-10	A72	general file description
	11	A40	data format
	12	A72	file description
	*13-END	V	source data (format from record 11)

Table 2. Data record structure for selected records. Word length is 16 bits.

File	Record	Word	Contents
.GEO	1-END	1	cell reference number
		2	column offset number
		3	cell row
		4	cell column
		5	latitude of cell center
		6	longitude of cell center
		7	cell type (LAND,OFFS,COAS, or OUTS)
		8	cell area (square km)
			[if the cell type is neither LAND nor OUTS, the following data are included]
		9	avg. depth along north side of cell (m)
		10	wetted width (km) along north side
		11	avg. depth along east side of cell (m)
		12	wetted width (km) along east side
		13	avg. depth along south side of cell (m)
		14	wetted width (km) along south side
		15	avg. depth along west side of cell (m)
		16	wetted width (km) along west side
.CUR	2-END	1	cell sequence number
		2	grid center latitude
		3	grid center longitude
		4,5	eastward, northward components (+ or -) of current (cm/s) for January
		6,7	" February
		8,9	" March
		10,11	" April
		12,13	" May
		14,15	" June
		16,17	" July
		18,19	" August
		20,21	" September
		22,23	" October
		24,25	" November
		26,27	" December
.REF	14-END	1	grid cell row number
		2	grid cell column number
		3	record number in .WND file which contains wind data for this cell

Table 2 (Cont'd)

File	Record	Word	Contents
.WND	1-END	1	record number
		2	latitude of wind data
		3	longitude of wind data
		4	month for data
		5,6	wind speed (kt), fraction of time wind is toward the south
		7,8	" south-west
		9,10	" west
		11,12	" north-west
		13,14	" north
		15,16	" north-east
		17,18	" east
		19,20	" south-east
.TRN	1-END	1	record number
		2	cell row number
		3	cell column number
		4	cell sequence number
		5,6	fraction dispersed to cell to north, northeast
		7,8	" east, south-east
		9,10	" south, south-west
		11,12	" west, north-west
		13	fraction remaining in cell
		14	cell area (square km)
.DSP	1-END	1	cell sequence number
		2	cell index (unused)
		3,4	cell column, row
		5-16	pollutant concentration (gal/sq. statute mi) for the months January - December
.SOR	13-END	1	cell sequence number
		2	cell index (unused)
		3,4	cell column, row.
		5-16	cell concentration (gal/ sq. statute mi) at start of each timestep for months January - December

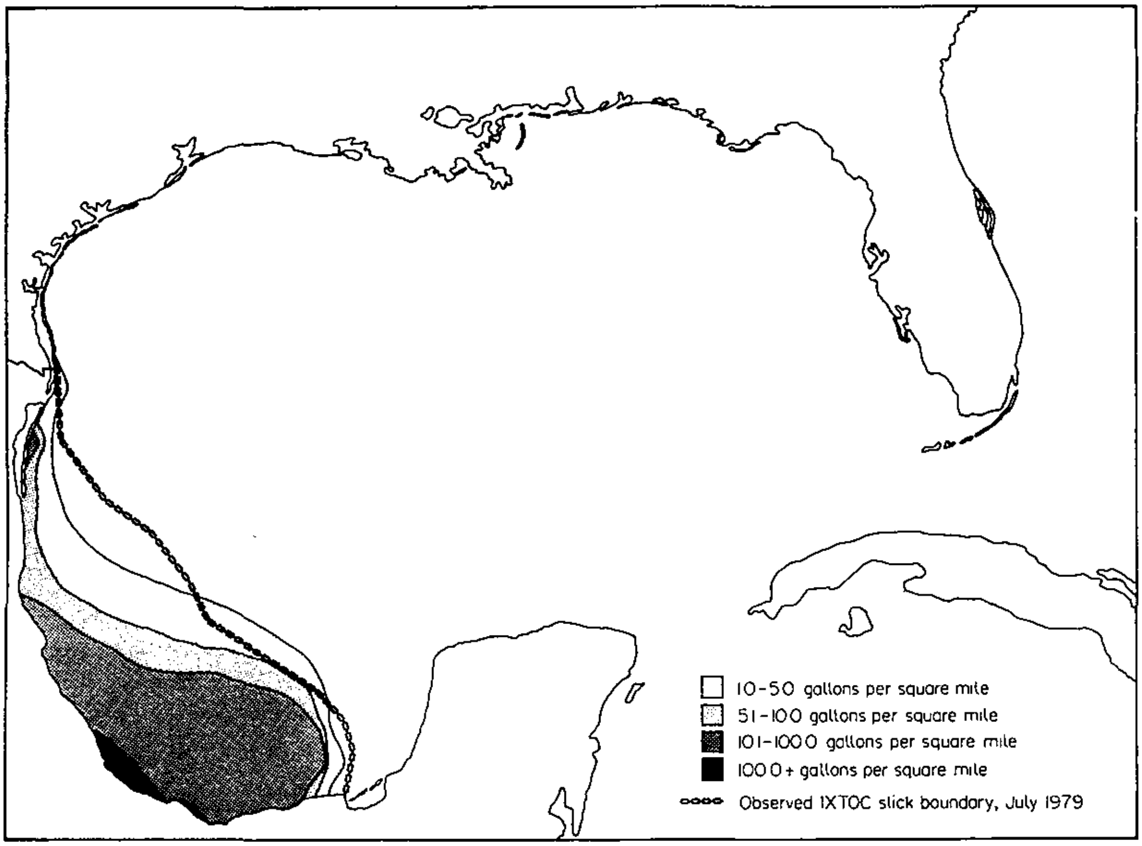


Figure 1. Comparison of observed boundaries of the oil from the IXTOC well site and the oil concentrations calculated from the TRANS, DISPRS, and BLENDR programs.

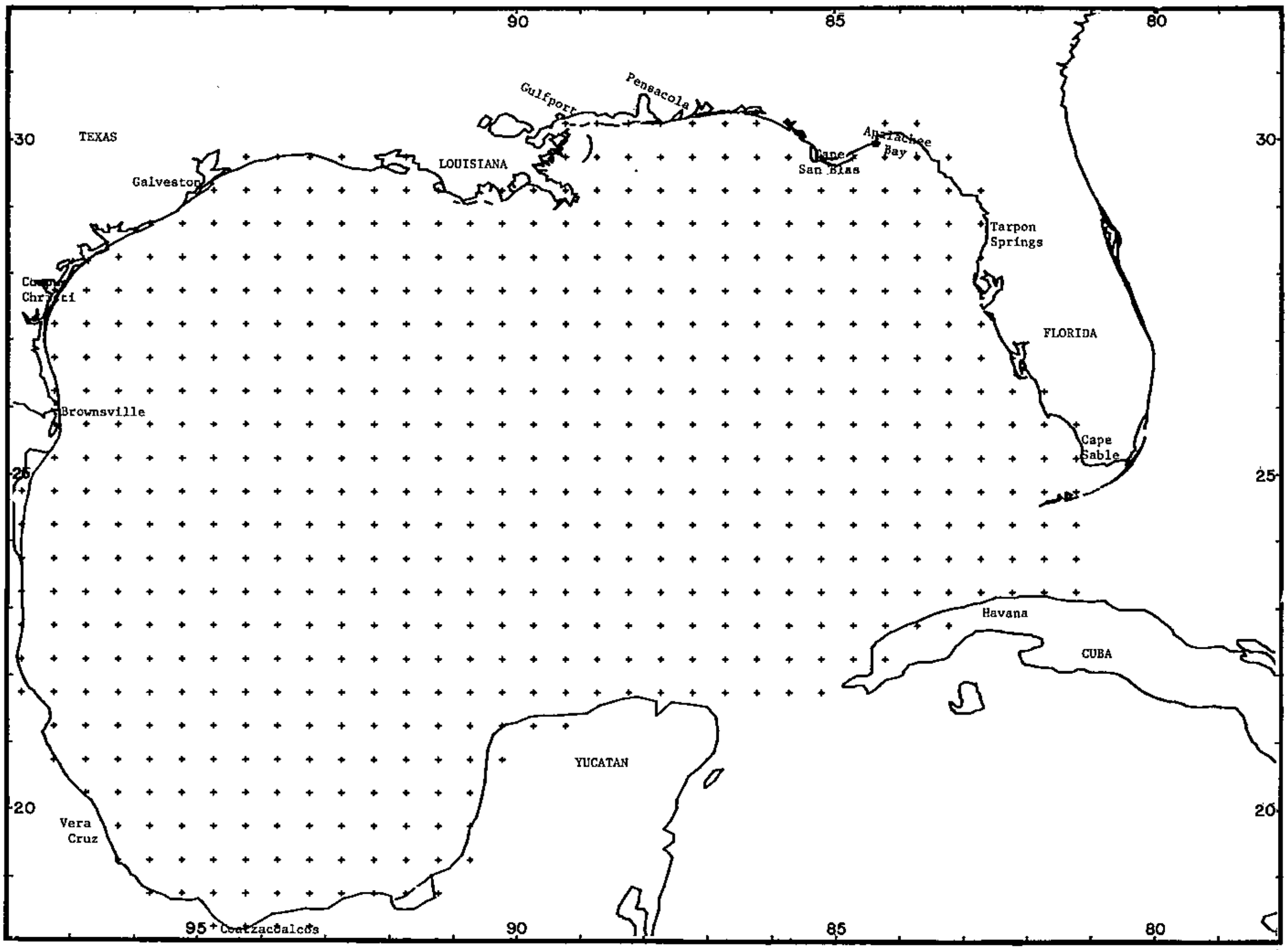


Figure 2. Grid mesh for the Gulf of Mexico.

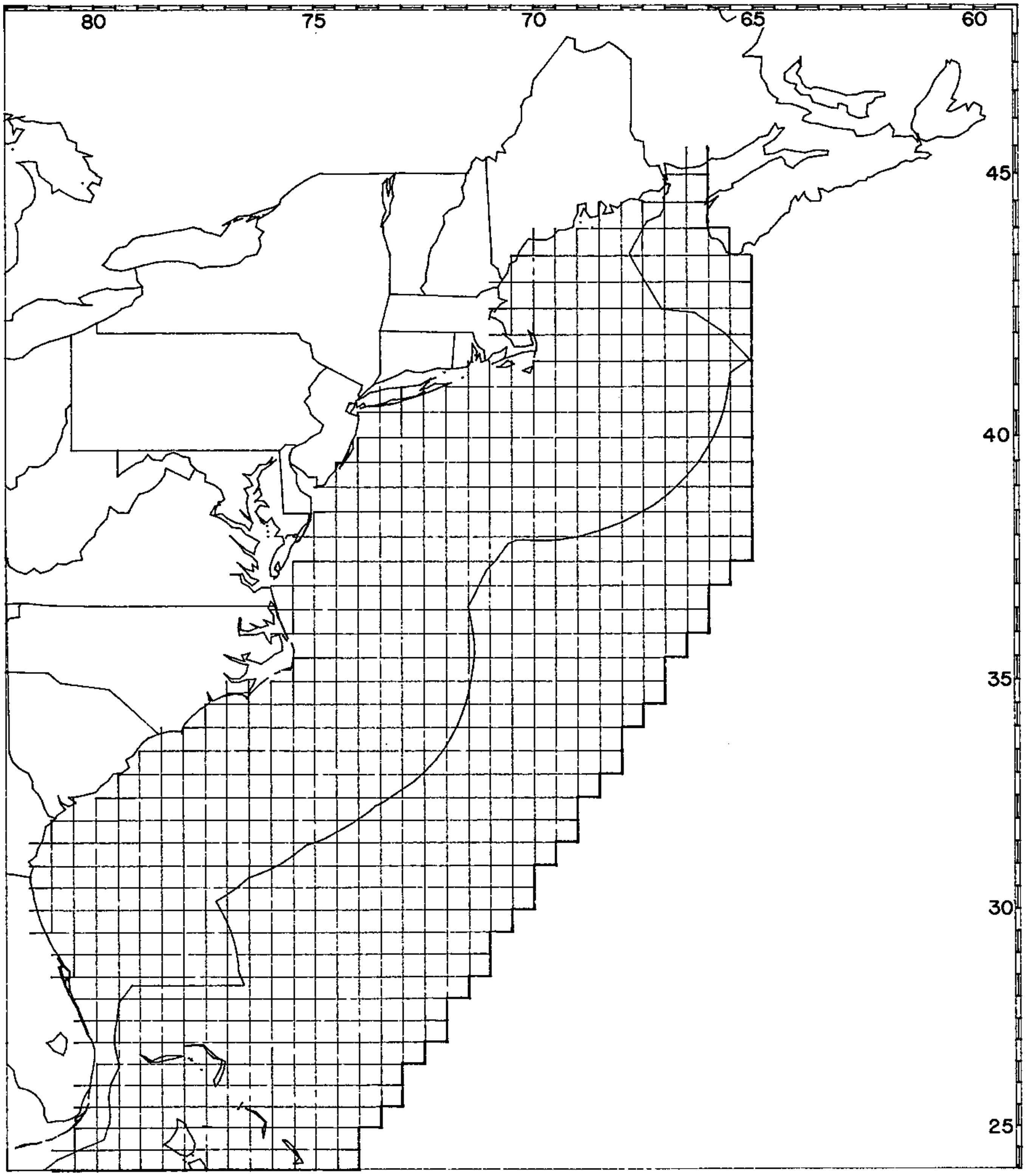


Figure 3. Grid mesh for the East Coast U.S.

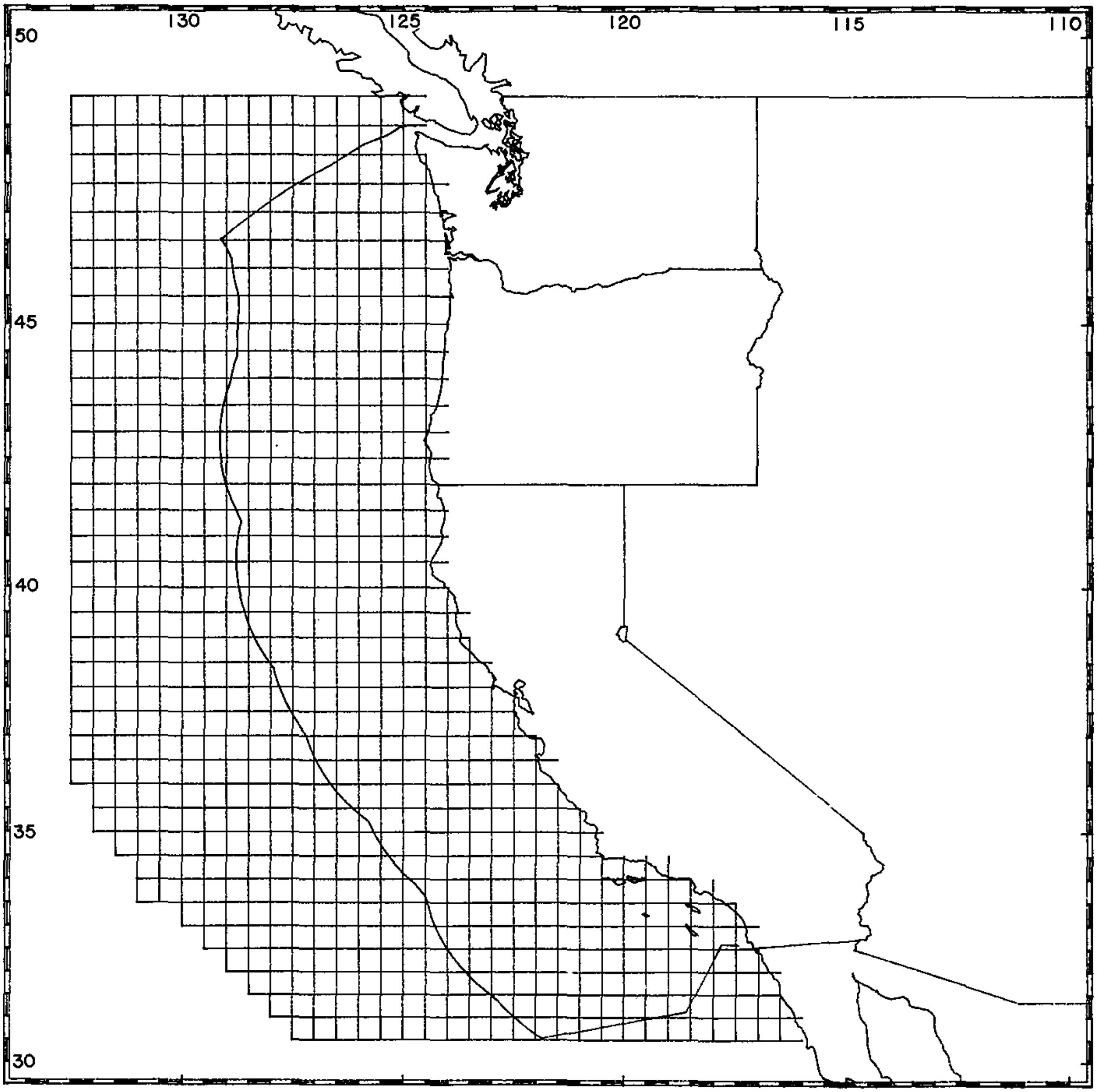
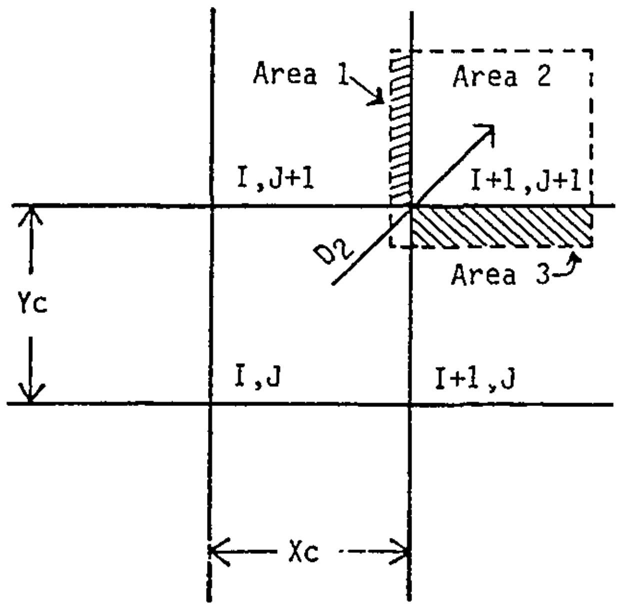


Figure 4. Grid mesh for the West Coast U.S.



Movement of Layer 2 during single time-step = $\vec{D_2} = \left[\vec{V} + (wf \cdot \vec{W_2})\right] \cdot \Delta t$

where: V = local currents for cell (I,J),
wf = 3.5% = wind drift factor,
W_2 = mean wind speed for Trajectory 2 for cell (I,J).

Material to be added to cell (I,J+1) = h_2 • Area 1
Material to be added to cell (I+1,J+1) = h_2 • Area 2
Material to be added to cell (I+1,J) = h_2 • Area 3
Material remaining in cell (I,J) = h_2 • (A - Area 1 - Area 2 - Area 3)

where: A = total cell area = Xc • Yc,
h_2 = layer thickness = frequency of occurrence of winds toward trajectory #2.

Figure 5. Illustration of the cell outline translation used in calculation of the transition matrices.

1, control file for GULF OF MEXICO
.JLFTRN.GEO
GULFTRN.CUR
190
GULFTRN.REF
GULFTRN.WND
GULFTRN.DES
GULFTRN.TRN
615 884 25 34 18.0 98.0 8
GULFTRN.DSP
GULFTRN.HED

(B) 2, control file for EAST COAST
EASTTRN.GEO
EASTTRN.CUR
200
EASTTRN.REF
EASTTRN.WND
EASTTRN.DES
EASTTRN.TRN
745 745 43 33 24.0 81.5 8
EASTTRN.DSP
EASTTRN.HED

(C) +3, control file for WEST COAST
WESTTRN.GEO
WESTTRN.CUR
208
WESTTRN.REF
WESTTRN.WND
WESTTRN.DES
WESTTRN.TRN
785 788 37 33 30.5132.5 10
WESTTRN.DSP
WESTTRN.HED

Figure 6. Contents of the three control files GULFTRN.CRL (A), EASTTRN.CRL (B), and WESTTRN.CRL (C).

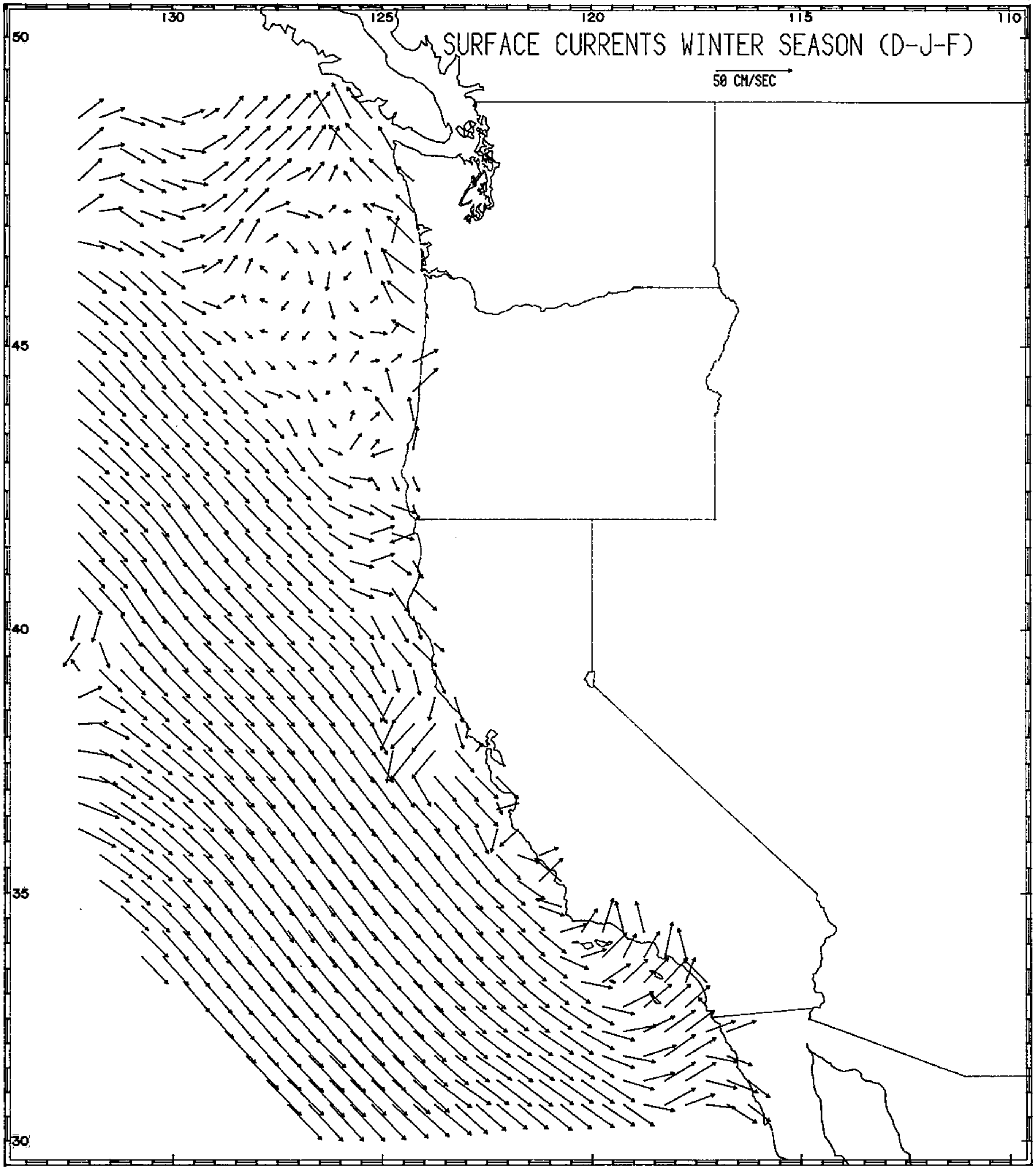


Figure 7. Mean geostrophic surface current vectors for the West Coast for January.

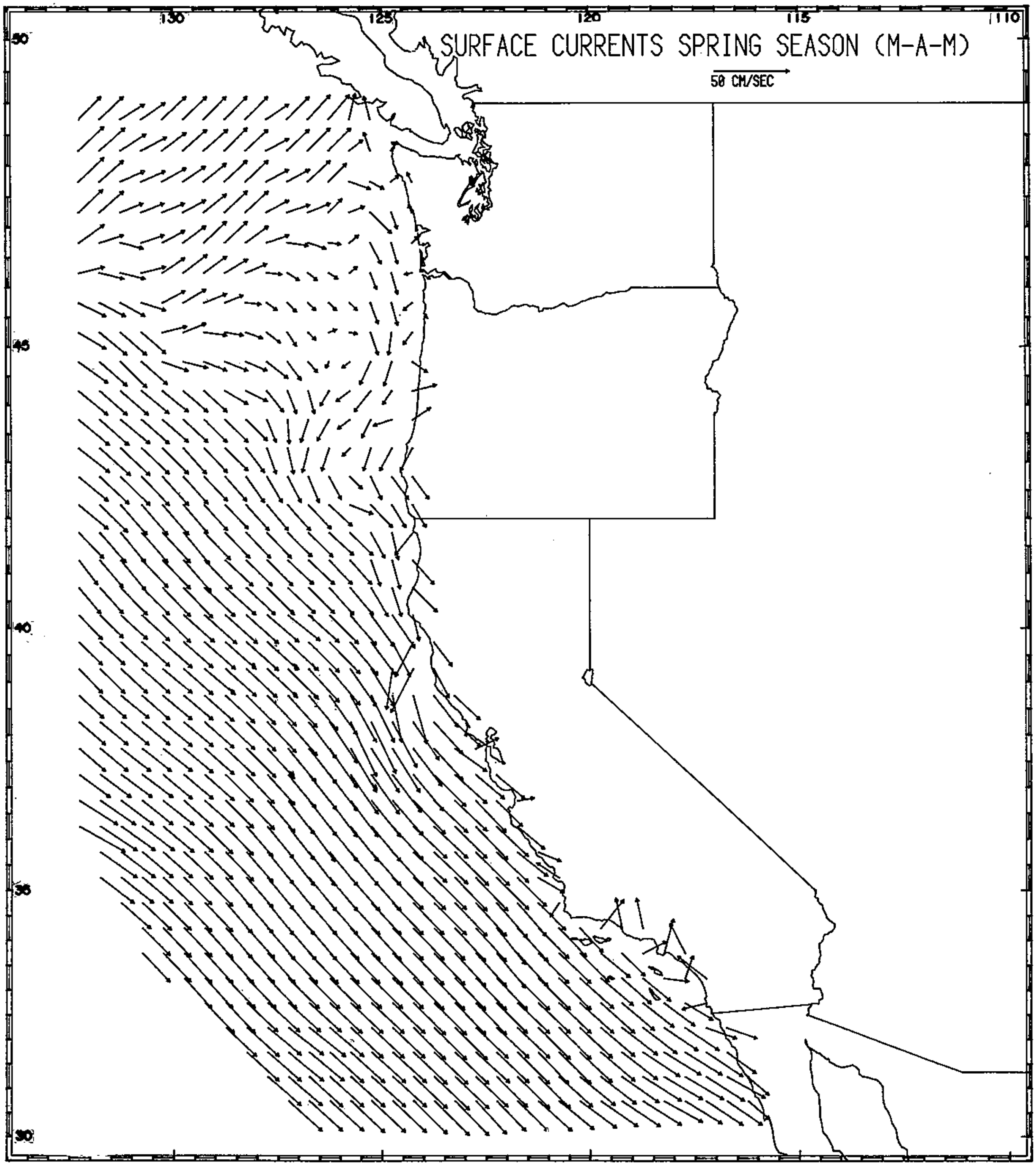


Figure 8. Same as Fig. 7, but for April.

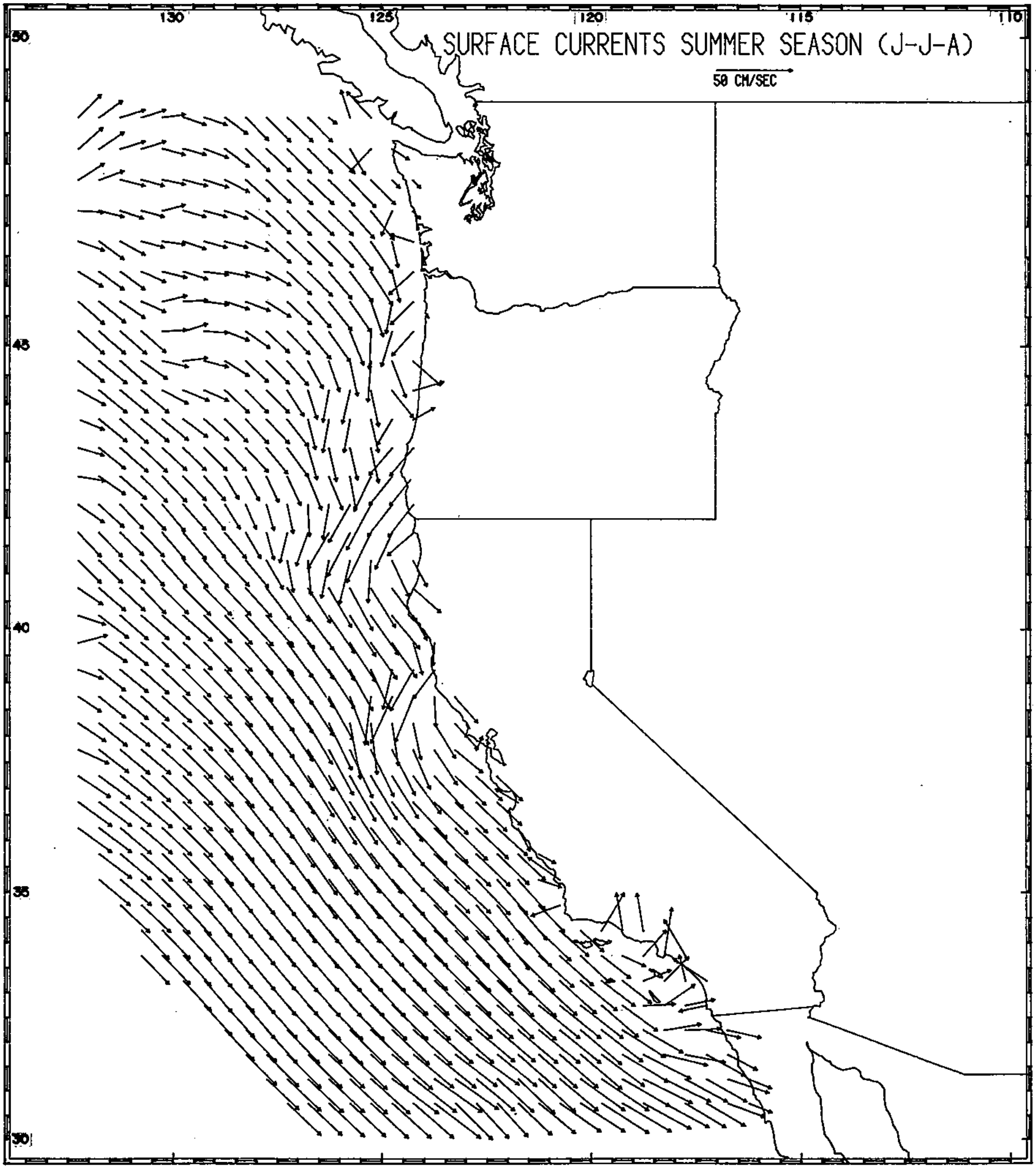


Figure 9. Same as Fig. 7, but for July.

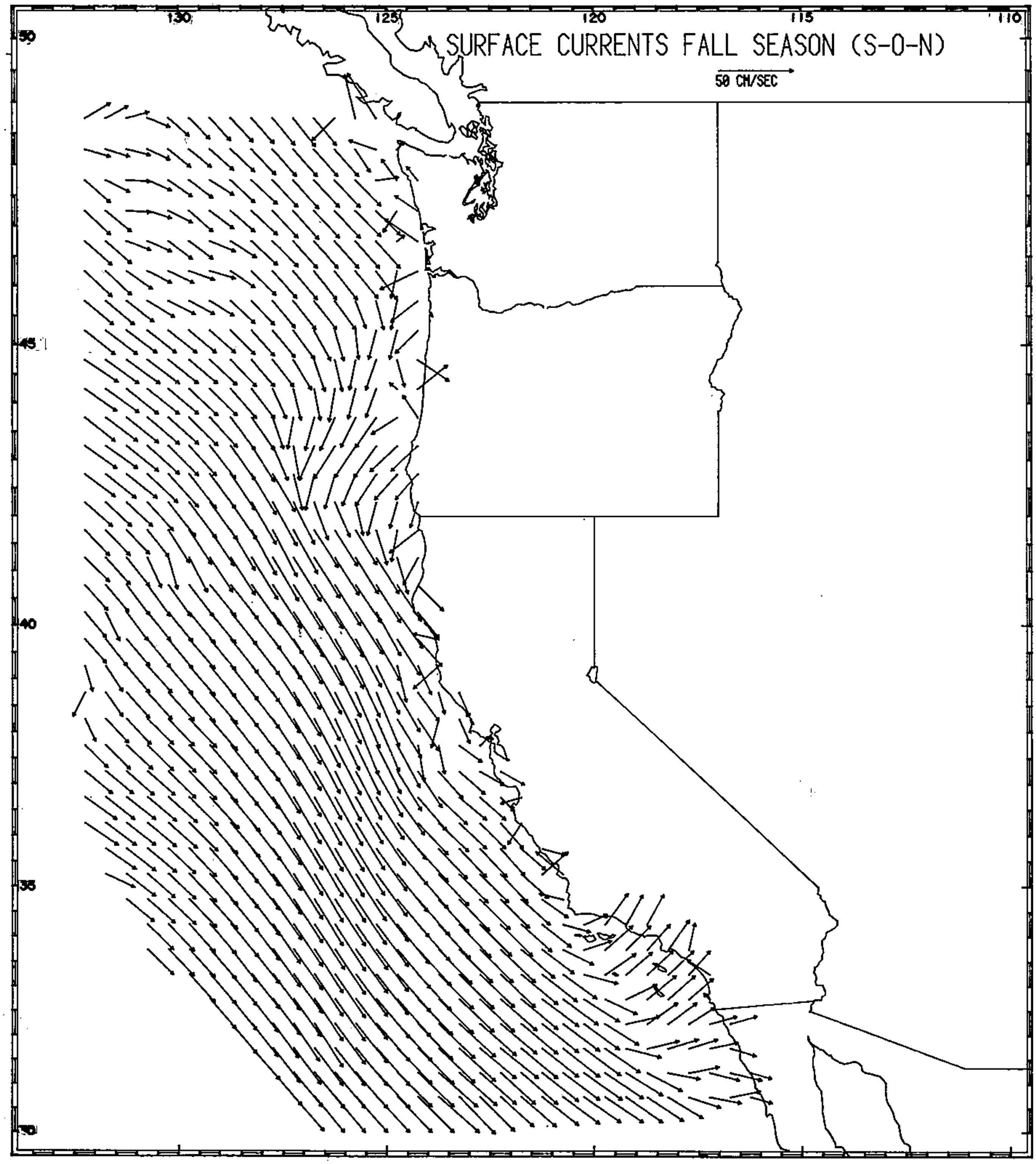


Figure 10. Same as Fig. 7, but for October.

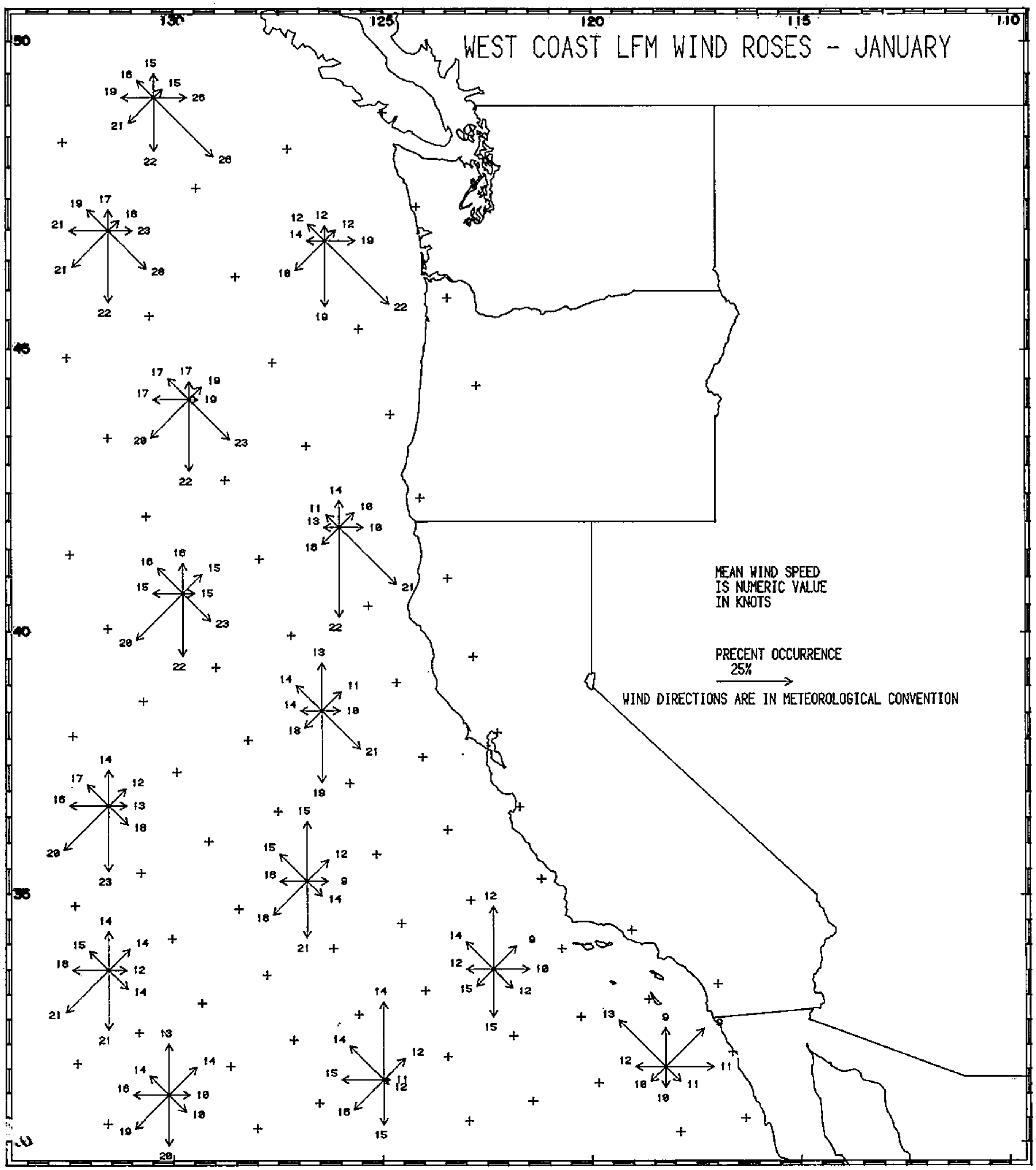


Figure 11. Wind histograms for the West Coast for January.

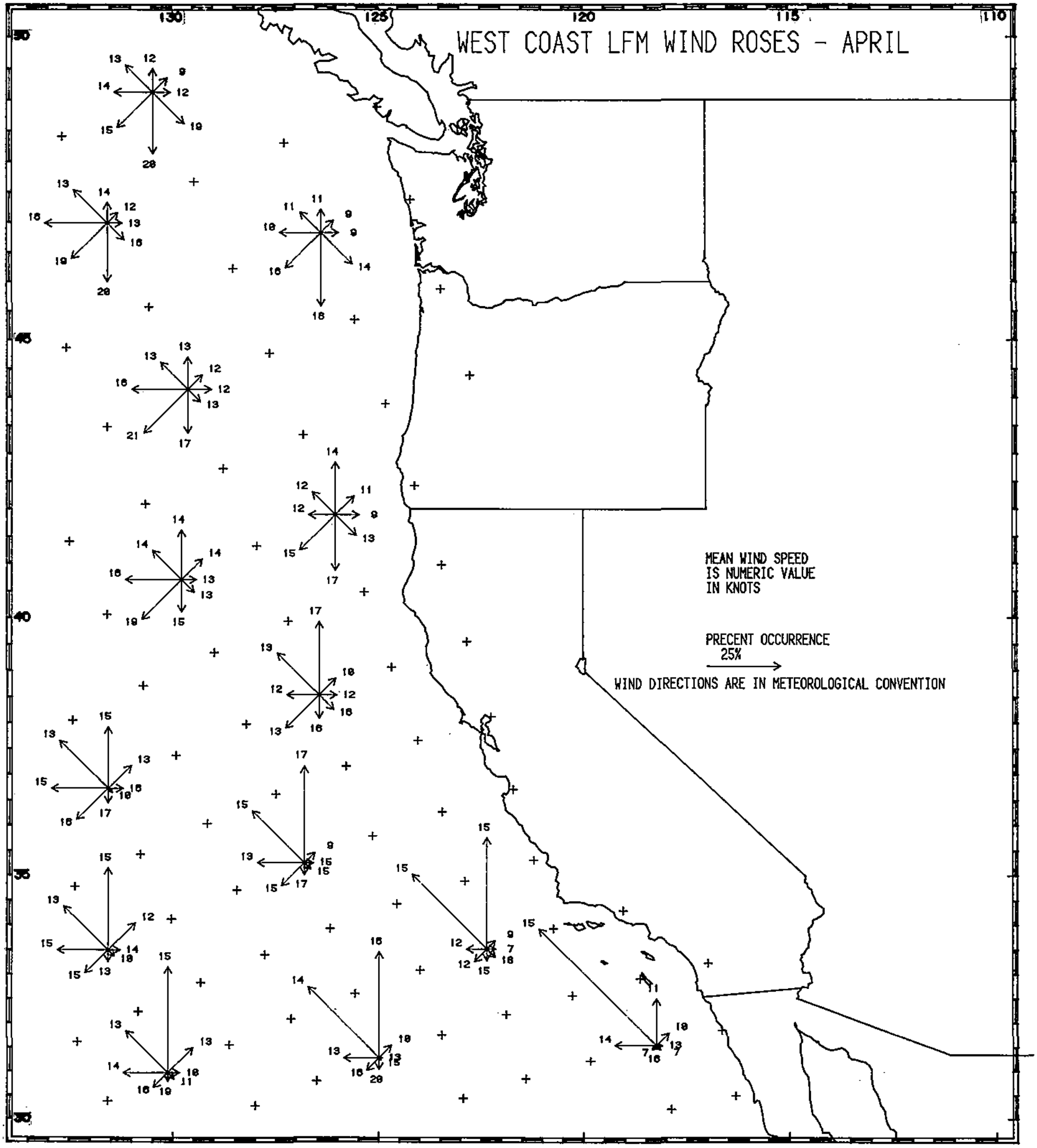


Figure 12. Same as Fig. 11, but for April.

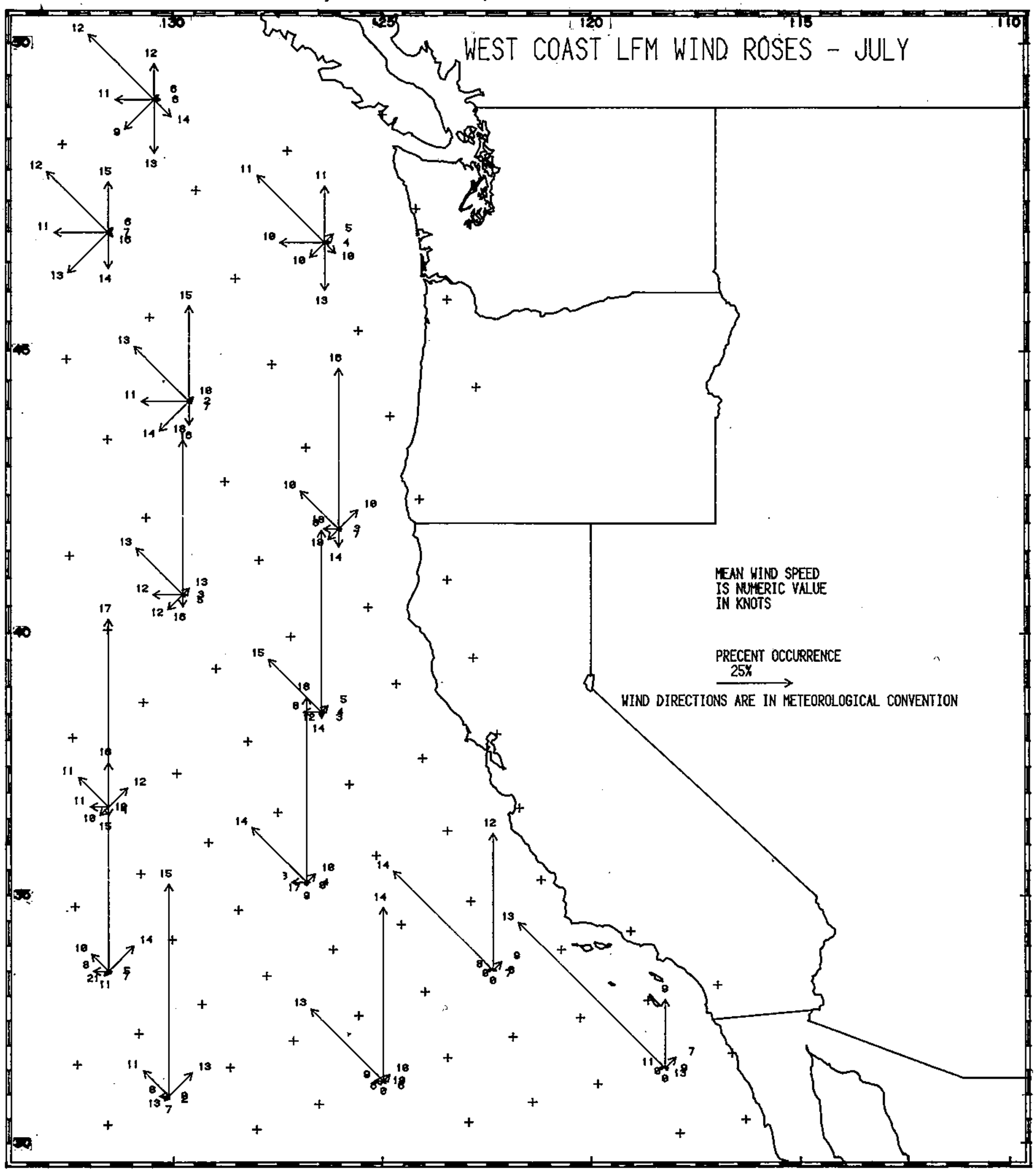


Figure 13. Same as Fig. 11, but for July.

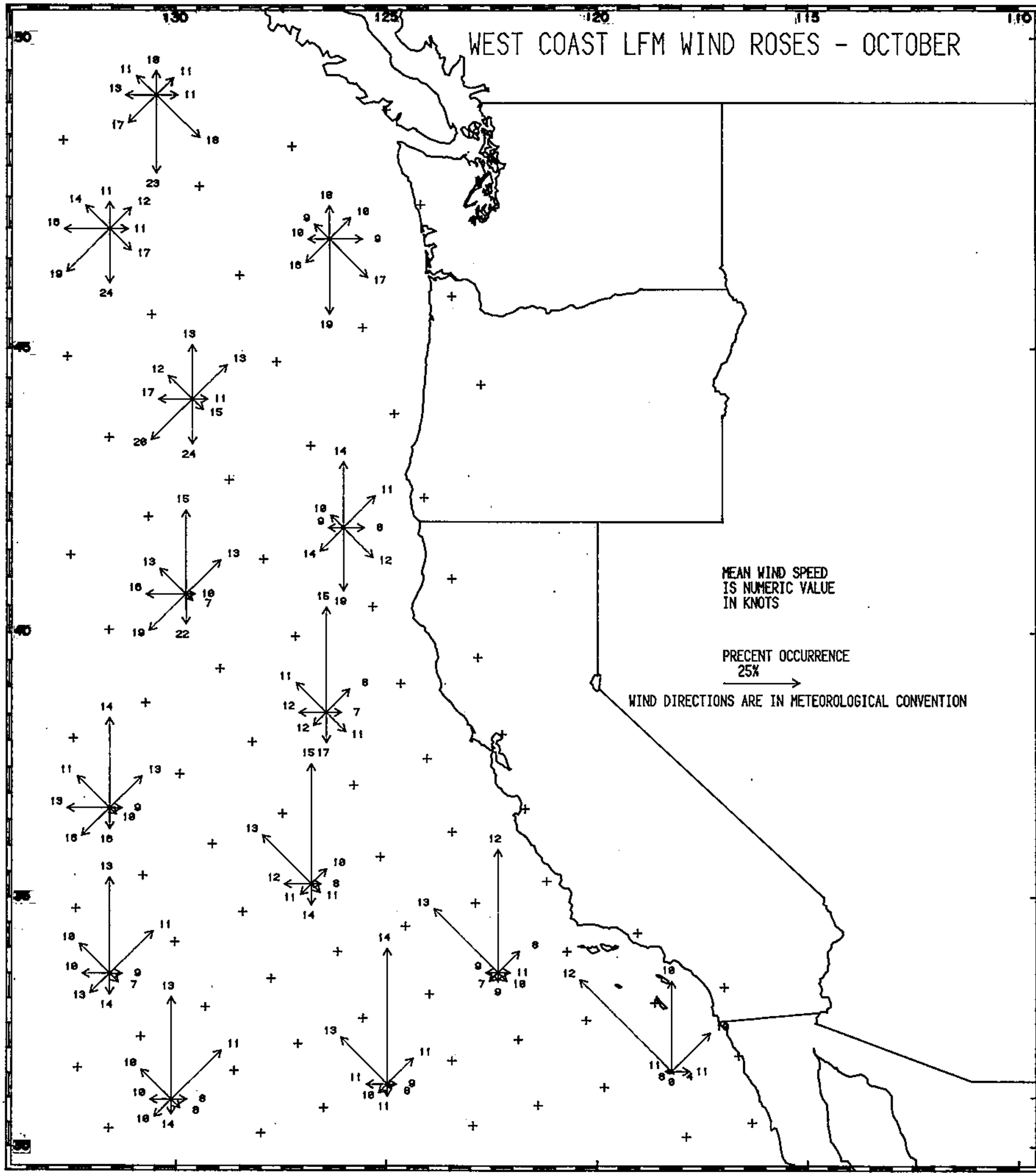


Figure 14. Same as Fig. 11, but for October.

```
SURFACE TRANSITION MATRIX   5-DEC-84 08:42:39
NUMBER OF CELLS =  745    STEP= 8 HOURS
MONTHS  1 TO 12
CURRENTS FROM EASTTRN.CUR
WIND DATA FROM EASTTRN.WND                        EASTTRN.REF
IMEAN=  1
OUTPUT FILES ARE EASTTRN.DES                       EASTTRN.TRN

MAX MOVEMENT AND SPEED FOR MONTH =  1
    NORTH=  47.14 KM   163.68 CM/SEC  CELL= 106 DIR= 1  # BAD=   0
     EAST=  28.78 KM    99.91 CM/SEC  CELL=  34 DIR= 3  # BAD=   0

MAX MOVEMENT AND SPEED FOR MONTH =  2
    NORTH=  44.32 KM   153.90 CM/SEC  CELL=  92 DIR= 1  # BAD=   0
     EAST=  28.71 KM    99.69 CM/SEC  CELL= 599 DIR= 3  # BAD=   0

MAX MOVEMENT AND SPEED FOR MONTH =  3
    NORTH=  44.11 KM   153.17 CM/SEC  CELL= 106 DIR= 1  # BAD=   0
     EAST=  29.95 KM   103.98 CM/SEC  CELL=  34 DIR= 3  # BAD=   0

MAX MOVEMENT AND SPEED FOR MONTH =  4
    NORTH=  45.31 KM   157.32 CM/SEC  CELL= 122 DIR= 1  # BAD=   0
     EAST=  29.64 KM   102.93 CM/SEC  CELL= 576 DIR= 3  # BAD=   0

MAX MOVEMENT AND SPEED FOR MONTH =  5
    NORTH=  44.21 KM   153.50 CM/SEC  CELL= 122 DIR= 1  # BAD=   0
     EAST=  28.27 KM    98.17 CM/SEC  CELL= 576 DIR= 3  # BAD=   0

MAX MOVEMENT AND SPEED FOR MONTH =  6
    NORTH=  42.19 KM   146.50 CM/SEC  CELL= 122 DIR= 1  # BAD=   0
     EAST=  28.01 KM    97.27 CM/SEC  CELL= 336 DIR= 3  # BAD=   0

MAX MOVEMENT AND SPEED FOR MONTH =  7
    NORTH=  40.82 KM   141.75 CM/SEC  CELL=  92 DIR= 1  # BAD=   0
     EAST=  27.52 KM    95.55 CM/SEC  CELL= 336 DIR= 3  # BAD=   0

MAX MOVEMENT AND SPEED FOR MONTH =  8
    NORTH=  42.93 KM   149.07 CM/SEC  CELL=  92 DIR= 1  # BAD=   0
     EAST=  27.76 KM    96.39 CM/SEC  CELL= 336 DIR= 2  # BAD=   0

MAX MOVEMENT AND SPEED FOR MONTH =  9
    NORTH=  44.15 KM   153.29 CM/SEC  CELL=  92 DIR= 1  # BAD=   0
     EAST=  28.70 KM    99.66 CM/SEC  CELL= 336 DIR= 2  # BAD=   0

MAX MOVEMENT AND SPEED FOR MONTH = 10
    NORTH=  37.86 KM   131.48 CM/SEC  CELL= 106 DIR= 8  # BAD=   0
     EAST=  25.97 KM    90.18 CM/SEC  CELL= 336 DIR= 3  # BAD=   0

MAX MOVEMENT AND SPEED FOR MONTH = 11
    NORTH=  39.40 KM   136.81 CM/SEC  CELL= 106 DIR= 1  # BAD=   0
     EAST=  26.08 KM    90.54 CM/SEC  CELL= 595 DIR= 3  # BAD=   0

MAX MOVEMENT AND SPEED FOR MONTH = 12
    NORTH=  40.02 KM   138.95 CM/SEC  CELL=  92 DIR= 1  # BAD=   0
     EAST=  27.40 KM    95.13 CM/SEC  CELL= 573 DIR= 3  # BAD=   0

RESULTS OF ERROR CHECKING:
    NO. OF N-S DISPLACEMENTS TOO LARGE=    0  RNOR=0.8571
    NO. OF E-W DISPLACEMENTS TOO LARGE=    0  REAS=0.6814
  RUN OUTPUT SHOULD BE ACCEPTABLE
```

Figure 15. Typical output from the program TRANS. At the end of each month, TRANS prints the the maximum excursion (km) and velocity (cm/s), and the grid cell in which they occurred, and the number of bad cells, for the north-south and east-west directions. If the excursion exceeds the cell dimension, the cell calculation is bad. The timestep is specified in the control file (Fig. 6).

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